

Report No. FAA-RD-71-104

INTERMEDIATE ACTIVITY LEVEL TOWER CAB EVALUATION-PHASE II

AD735131

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transpo 

U.S. International Transportation Exposition
Dulles International Airport
Washington, D.C.
May 27-June 4, 1972

DECEMBER 1971

FINAL REPORT

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Prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

Systems Research & Development Service

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|--|--|---|-----------|
| 1. Report No. FAA-RD-71-104 | 2. Government Accession No. | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle INTERMEDIATE ACTIVITY LEVEL TOWER CAB EVALUATION - PHASE II | | 5. Report Date December 1971 | |
| | | 6. Performing Organization Code | |
| 7. Author(s) J. Roy Bradley, Jr. | | 8. Performing Organization Report No. FAA-NA-72-2 | |
| 9. Performing Organization Name and Address National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405 | | 10. Work Unit No. | |
| | | 11. Contract or Grant No. Project No. 144-170-06X | |
| 12. Sponsoring Agency Name and Address FEDERAL AVIATION ADMINISTRATION Systems Research and Development Service Washington, D. C. 20591 | | 13. Type of Report and Period Covered Final Report July 1971-September 1971 | |
| | | 14. Sponsoring Agency Code | |
| 15. Supplementary Notes | | | |
| 16. Abstract This project was conducted to determine Air Traffic Controllers acceptance of an intermediate activity level airport traffic control tower, proposed for construction on a national basis, and to obtain suggestions for improving the proposed facility. Full-scale mockups of the tower cab and associated junction room were constructed and equipped with operational equipments at the National Aviation Facilities Experimental Center, Atlantic City, New Jersey. A 2-week evaluation was conducted with participation by air traffic control specialists from each of the 11 Federal Aviation Administration's regions. Results indicate that the proposed tower would be highly acceptable from an operational, as well as an environmental standpoint. Concern was expressed over the large size of the tower cab corner posts and window mullions and over unknown factors relative to the adequate performance of the heating, ventilating, and air conditioning system. Numerous suggestions for both local and national application were determined and documented. | | | |
| 17. Key Words Airport Traffic Control Tower Control Tower Junction Room Control Tower Consoles Control Tower Equipments Light Systems Floor Covering | | 18. Distribution Statement Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public. | |
| 19. Security Classif. (of this report) Unclassified | 20. Security Classif. (of this page) Unclassified | 21. No. of Pages 51 | 22. Price |

PREFACE

The participation and assistance of the following persons during the evaluation are gratefully acknowledged.

| <u>Region</u> | <u>ATCS</u> | <u>Facility</u> |
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PREFACE (continued)

| <u>Region</u> | <u>ATCS</u> | <u>Facility</u> |
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INTRODUCTION

Purpose

The purpose of this project was to determine controllers' acceptance of a newly developed air traffic control tower, proposed for installation on a national basis, and to obtain maximum controller-oriented comments pertaining to critical operational and environmental features which could affect the efficiency of tower personnel.

Background

In the fall of 1969, a Congressional Committee provided \$10.8 million to the Federal Aviation Administration's (FAA) 1970 F&E appropriations for procurement of 54 new airport traffic control towers. Geographic locations designated to receive these towers are presented in Appendix A. In response, the FAA began investigations of various tower cab designs that would meet those funding recommendations and that would satisfy the agency's operational and technical requirements for an intermediate activity level, visual flight rule (VFR) tower facility.

A proposed design was developed for the FAA by Golemon and Rolfe Architects (G&R), Houston, Texas.

In Phase I, the National Aviation Facilities Experimental Center (NAFEC) constructed a full-scale mockup of the G&R-designed tower cab for evaluation and experimentation. An operators console and other features were developed with input from Air Traffic Service (ATS), Systems Research and Development Service (SRDS), Airway Facilities Service (AFS), controllers from the Eastern, Central, and Southern Regions and the NAFEC project team. Recommendations resulting from this study were incorporated in the NAFEC laboratory in static form and demonstrated to the FAA Agency Review Board (ARB) during June 1971. At that time, the Deputy Administrator of the FAA recommended that the tower mockup be refurbished with actual functioning equipments and innovations developed in Phase I and that NAFEC conduct a Phase II operational appraisal of the fully equipped tower cab. The Deputy Administrator further directed that three journeymen ATCS be selected from each of the 11 FAA Regions, to participate as test subjects, along with the six ATCS's who were active in Phase I. The junction room level of the control tower structure (that level immediately below the tower cab) was mocked up and included in the test exercises. The study objectives were:

1. Determine controllers' acceptance of the tower cab.
2. Evaluate and report on specific operational and environmental features incorporated in the tower cab and junction room mockups.
3. Obtain field controllers' suggestions for improving the proposed facility.

DISCUSSION

General

The basic parameters for the evaluation were that the tower would be used for a VFR type of operation and that the positions of operation would include two air/ground and one flight data position or any less combination of the three positions.

Method of Approach

The NAPEC project team consisted of three ATCS's and a research psychologist, who developed the evaluation procedures and subjective questionnaires. Groups of controllers were given an indoctrination briefing during which a one-sixth scale model of the tower cab and associated junction room was used for familiarization and explanation (Figure 1).

After the initial briefing, the groups were divided into two teams of three men. One team critiqued the tower laboratory and the other the junction room laboratory.

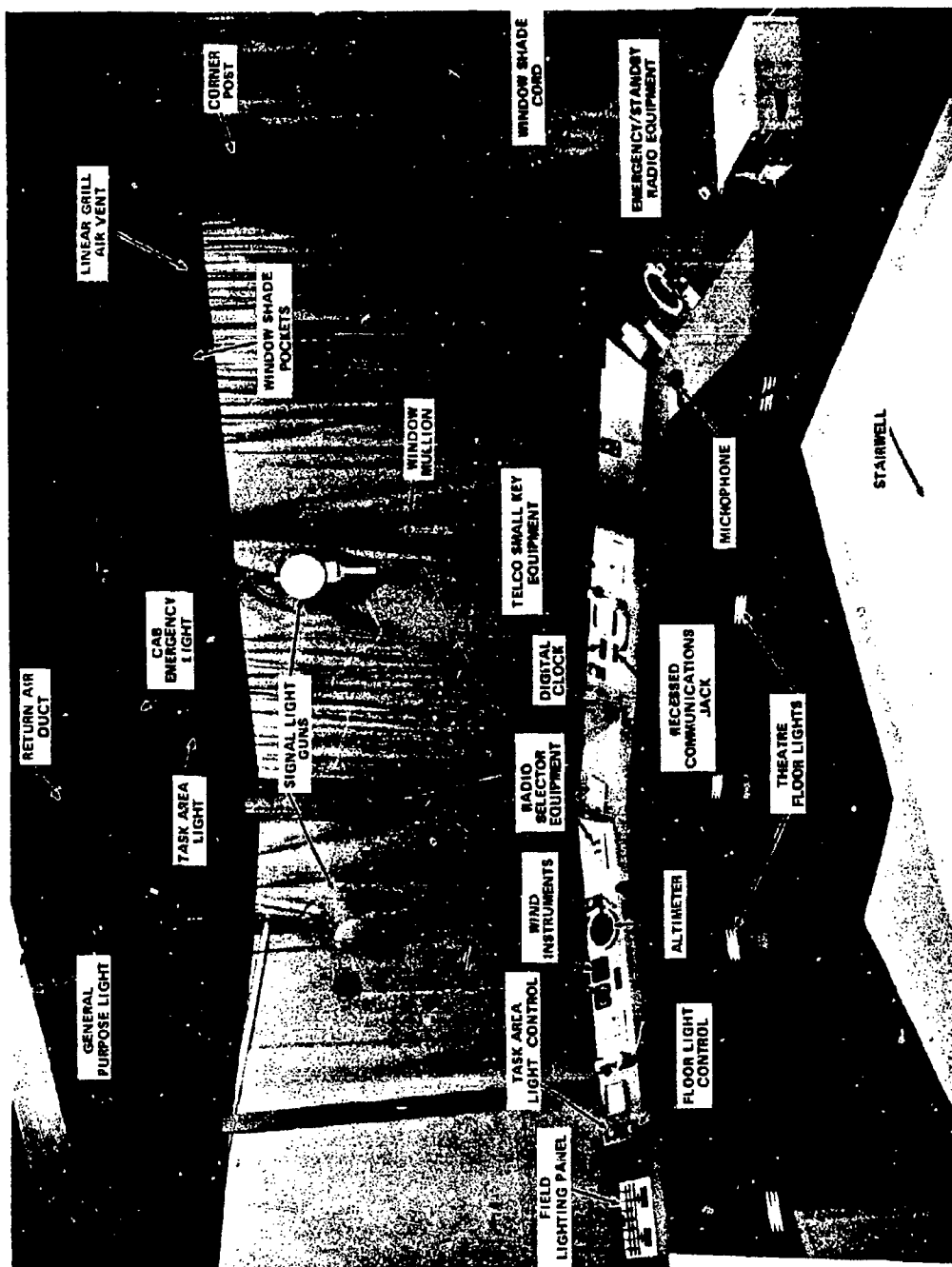
In the tower laboratory (Figures 2 and 3) subjects pantomimed those activities performed during a normal workday in a tower, i.e., they used the signal light guns, adjusted window shades, read instruments, keyed microphones, adjusted position lights, made coffee, etc.

In the junction room laboratory, the subjects evaluated visibility through the catwalk, color schemes, light systems, stairway design, lavatory arrangement, and access to the catwalk. The junction-room laboratory is presented in Figure 4. Written questionnaires were administered to each subject upon completion of the laboratory exercises. On the afternoon of the first day the two teams exchanged laboratory assignments and completed appropriate questionnaires. The second day was devoted to debriefing of the six-man group.



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FIGURE 1 - SCALE MODEL OF INTERMEDIATE ACTIVITY LEVEL
TOWER CAB AND JUNCTION ROOM



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FIGURE 2 - NAFEC TOWER CAB LABORATORY



FIGURE 3 - NAFEC TOWER CAB LABORATORY SHOWING CONVENIENCE
UNIT AND BOOKCASE

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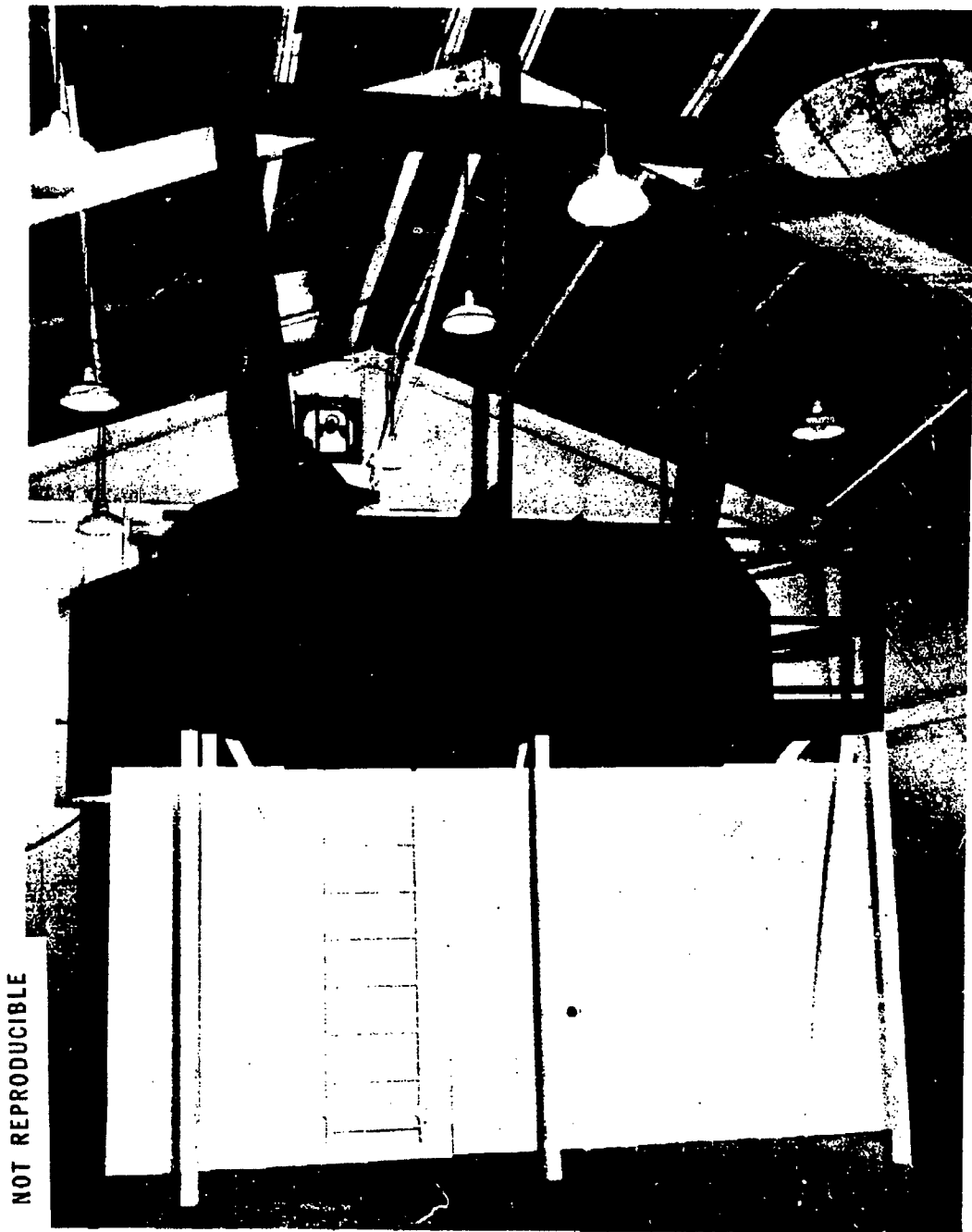


FIGURE 4 - NAFEC TOWER CAB LABORATORY SHOWING JUNCTION
ROOM LEVEL AND TOWER CAB BASE

Results

The following results are subjective and were obtained from written questionnaires, discussions in the laboratories, and the final debriefing with the controllers. A detailed list of controllers comments and suggestions is presented in Appendix B. A compilation of the results of the questionnaires is presented in Appendix C. The detailed results are listed below.

The Tower Cab: The tower cab is six-sided, has a 10-foot clear ceiling space, vertical walls to the window sill, and the windows slope outward at 15°. As shown in Figure 2, the tower cab corner posts have a maximum cross-sectional dimension, as viewed from any angle, of 14 inches; while a similar measurement for the window mullions is 4 1/2 inches. It was noted that the tower cab size and shape satisfied operational requirements; however, concern was expressed over the comparatively large size of the corner posts and window mullions.

The Heating, Ventilation, and Air Conditioning System: The heating, ventilation and air conditioning system (HVAC) was not installed for evaluation; however, the design requires that the proposed system be mounted on the roof of the tower cab. The system is to provide a flow of air through linear grills installed in the ceiling adjacent to the windows, down the tower windows and subsequently through three return air grills near the center of the ceiling. The operators' consoles will be vented in the back at the window sill level and in the front near the bottom of the base unit to facilitate the flow of air. Because the participating controllers represented geographic areas where temperature extremes varied from well below zero degrees to well above 100° fahrenheit, the HVAC system was a subject of considerable interest. Although it was a matter of conjecture, it appears there are unknown factors relative to the adequate performance of the HVAC system and that a potentially serious problem could exist. Questions raised involved the overall adequacy of the system, the noise level, the force of air down the windows and over the console and the effect of the window shades which will be mounted in the ceiling just inboard of the linear grill work.

Transparent Shade FAA-E-2476: A new specification has been recently established for control tower cab window shades. Accordingly, four new shades were installed in the laboratory for evaluation. Features of the new shade are: 5-mil thickness, bias cut on side nearest a corner post and straight cut on side nearest a center window mullion, and smoke gray color.

The shades will be mounted in a recessed shade pocket 5 inches by 5 inches located just inboard of the HVAC system linear grills; when in use they will parallel the windows at a 15° slope and remain under constant tension. The 5-mil shade appears to be far superior to the 3-mil shade, which is in general use at the present time. There should be less distortion, less noise, smaller gaps between shades and a greater life expectancy with the new units. The location and operation of the shades was rated as good. There was some concern over trapping and/or movement of the air between the windows and the shades. In the six-sided cab there are 12 windows and a corresponding number of shades. It was pointed out that certain facilities actually have no requirements for shades; others require shades only on a selective basis; while others need a full complement of 12 shades. The feasibility of providing one shade for each of the six sides of the cab was discussed but not determined.

It was felt that shades need not be part of the original package, but should be ordered as a local option; on a selective basis after respective facilities have been commissioned.

Light Systems: The position (console) lights consisted of six units, Lightolier Model 7051, that were recessed mounted in the ceiling (Figure 2) over the operators' console. Each lamp had its own "push-to-click" off/on switch and dimmer control located on the console equipment turret. The adequacy of the position lights and location of the controls were judged excellent. It was suggested that a "turn-to-click" off/on switch and dimmer control would preclude activating the lamp at a high-intensity setting, thereby extending the life expectancy of the bulb.

The floor lights consisted of seven theatre-type lights recessed in the console bases. These lights were activated by a single off/on switch and dimmer control located in the console equipment turret. The adequacy and location of the system were considered excellent.

General Lighting: A two-lamp, 40-watt fluorescent fixture with a dimming ballast and a parabolic wedge louver (to preclude reflection in tower windows) was mounted in the ceiling of the cab. This fixture was to be used as a general purpose light for house cleaning, etc. during low-traffic activity periods. The unit was considered very satisfactory.

Cab Emergency Light: In the event of power failure, a 12-Volt direct current (dc) emergency system automatically activates a small ceiling-mounted light. It was noted that, during the hours of darkness, instantaneous light from the emergency system could temporarily destroy a controllers' "night vision." It was suggested that a filter and dimming control be provided for this light.

Air Traffic Control Signal Light Guns: Two air traffic control signal light guns were provided in the laboratory. Because of a requirement for two-way radio at most controlled airports, light guns, today, are infrequently used by controllers. Therefore, the signal light guns were mounted well inboard from the front of the cab (Figure 2). Most controllers preferred this location. It was brought out, however, that certain facilities still conduct an active signal-light gun operation. For those facilities it would be appropriate to move the light guns outboard toward the windows to a more readily accessible location.

Consoles: The operators' console was developed in Phase I. The basic components consist of a small base unit, a 12-inch shelf and equipment turret. The console shown in Figure 2 has a writing surface 30 inches above the floor. This is considered a normal "sit" console. There is an 8-inch spacer component that may be provided as an option. The purpose of the spacer is to raise the shelf and equipment 8-inches higher for a "sit/stand" operation. FAA regions may order any combination of sit or sit/stand arrangement that suits individual regional requirements. The console is finished with a gingersnap colored, glare-free matte finished formica which was rated excellent.

Equipment: The following equipment (Figures 2 and 3) was provided in the cab mockup: field-lighting panel; telco small-key system (at the flight data position and one air/ground position); wind direction, wind speed and altimeter indicators (at the air/ground positions); miniaturized clocks (at all positions); two microphones; two GRM Type FA8165-06 frequency selector modules; two GRM Type FA8165-02 audio modules; one emergency/standby VHF transceiver; Domore Model 603E-14SP and Model H88X24 chairs as required; one bookcase; and one convenience unit (Acme Kitchen model RES-4AF-33).

The equipment was generally well received. The field-lighting panel was a mockup, but was representative of a miniaturized panel anticipated for use. The telco small-key equipment is scheduled for installation at the flight data

position and at one of the air/ground radio positions. At the air/ground position, the telco and radio equipment will perform as a single component; i.e., by key selection a controller can go from radio to telco system instantaneously and vice-versa, but the two systems cannot be operated simultaneously. For this reason some controllers felt that a third telco small-key system should be added in the towers. The majority of controllers noted that the recessed jacks for the handsets should be mounted in the console equipment turret. Dual wind direction, wind speed, and altimeter are planned, one set for each air/ground position. The dual installation concept is desirable; however, it was noted that the numerals were a different size for each of the three instruments. Suggestions were offered that research be conducted in developing a digital package for displaying this information.

The radio equipment is manufactured by GRM, Inc. The units displayed at the air/ground positions were selector modules and audio modules. These units were compact and it appears they will well serve the purpose for which they were designed. There were some requests for additional audio units (speakers) and for brighter lamps in the (frequency) selector modules.

The VHF emergency/standby transceiver was included as a static display. Several of the controllers were familiar with this equipment and reported its successful operation in the field.

An Acme Kitchen, Model RES-4AF-33, which is a combination range, refrigerator, sink, and storage closet was provided for evaluation (Figure 3). A cold water bubbler was retrofitted as an additional feature. The presence of the convenience unit and the instant ice water feature were considered excellent. The location was rated good to very good. A few suggestions were made to rotate the unit 90° to the left and locate it against the stairway guard.

The bookcase, a standard double decker GSA bookcase was provided. The short metal legs made the unit extend too high above the window sill, while the gray/green color was not harmonious with the tower decor. Consequently, the legs were removed and the bookcase painted a brown color that closely resembled the gingersnap color of the consoles. With these changes the bookcase blended more harmoniously with the cab interior.

Operator's Chairs - The operator's chairs shown in Figure 5, are on GSA Federal Supply Schedule and are being used successfully in the field. Their continued use is recommended.

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FIGURE 5 - TOWER CAB SHOWING THREE POSITIONS OF
OPERATIONS

Floor Covering - A pile vinyl carpet manufactured by Collins-Aikman, style H.E.F. Series 500, cinnamon color No. 27, that is on GSA Federal Supply Schedule, was installed on the floor and walls of the tower cab (Figures 2 and 3). This method of installation contributed significantly towards sound-proofing the cab. It also added to the general decor and comfort of the tower and had a very pleasing effect. A planned central vacuum cleaning unit will facilitate house cleaning chores.

The Tower Cab Color Scheme - the exterior of the tower cab will be brown/black, the inside of the corner posts, window mullions and window sills will be NAS brown, the consoles gingersnap with red cloth finished rubber on the shelves and the carpet cinnamon. This resulted in a harmonious blending of colors and the overall scheme was rated excellent by the controllers.

Position of Operation - The tower cab was evaluated on the basis of three positions of operation (Figure 5); two air/ground and one flight data, with the flight data position located between the two air/ground positions. Regions have been given the option of designating the desired position arrangement. The flight data position could be either centrally located or to the left or right of two adjacent air/ground positions. This option was considered a necessity. The tower cab was also evaluated as to the adequacy of floor space for four controllers and was rated fair to good. Two additional console modules were temporarily installed for the western regional planning personnel to explore the effect of a five-man operation. The two modules provided four more lateral feet of console space. It appeared that with the additional console space a five position VFR operation would be feasible.

The Junction Room Level: The purpose of the junction room level (Figure 4), in addition to adding height to the tower structure, is to provide an area for a stairway to other levels, elevator shaft or storage room, water pipe chase, lavatory, ac and dc panel boards, equipment racks and clothes rack. The junction room level was rated as follows; stairs from the tower cab to the catwalk landing (Figure 6) and from this landing down to the junction room (Figure 7), very good. The stairs to the lower levels, although not mocked-up, met the standard codes for handrail safety. However, it was suggested that a wire mesh installation be included with the handrail as an added protection feature for facility personnel and visitors.

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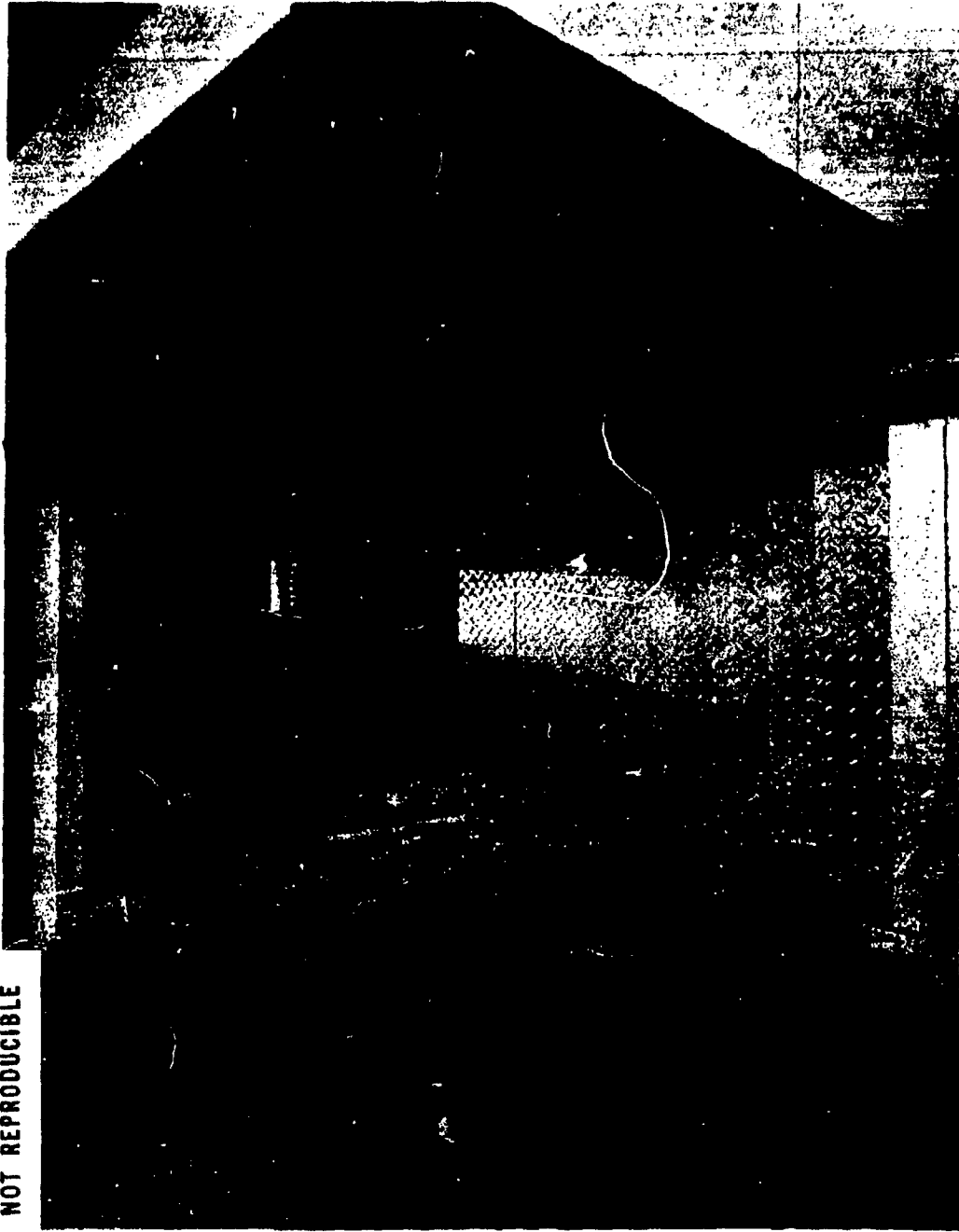


FIGURE 6 - TOWER CAB STAIRS AND ACCESS TO CATWALK

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FIGURE 7 - TOWER CAB STAIRS TO JUNCTION ROOM

Towers 50 feet or greater in height will be provided with an elevator. The majority of the towers will be 30-feet high. It has been planned to use the vacant elevator shaft area in the 30-foot facilities as storage rooms. This plan was acknowledged as a necessity. The lavatory and junction room were rated as good, however, it was felt that a lower ceiling in the lavatory would facilitate heating and ventilating the room and improve the general appearance. It was further noted that the hot water heater was inappropriately located under the washstand. In the junction room (Figure 8) the lack of safety covers to protect the equipment from visitors, and of personal lockers was pointed out. The lighting in the junction room was very good; however, the possibility existed that too much light might be reflected up the stairs into the tower cab. The stair lights to the cab were satisfactory, but should have a dimmer. The junction-room level has specified white for exterior walls, the inside of the exterior walls is gray/green and other inside walls are white. This color scheme was judged satisfactory.

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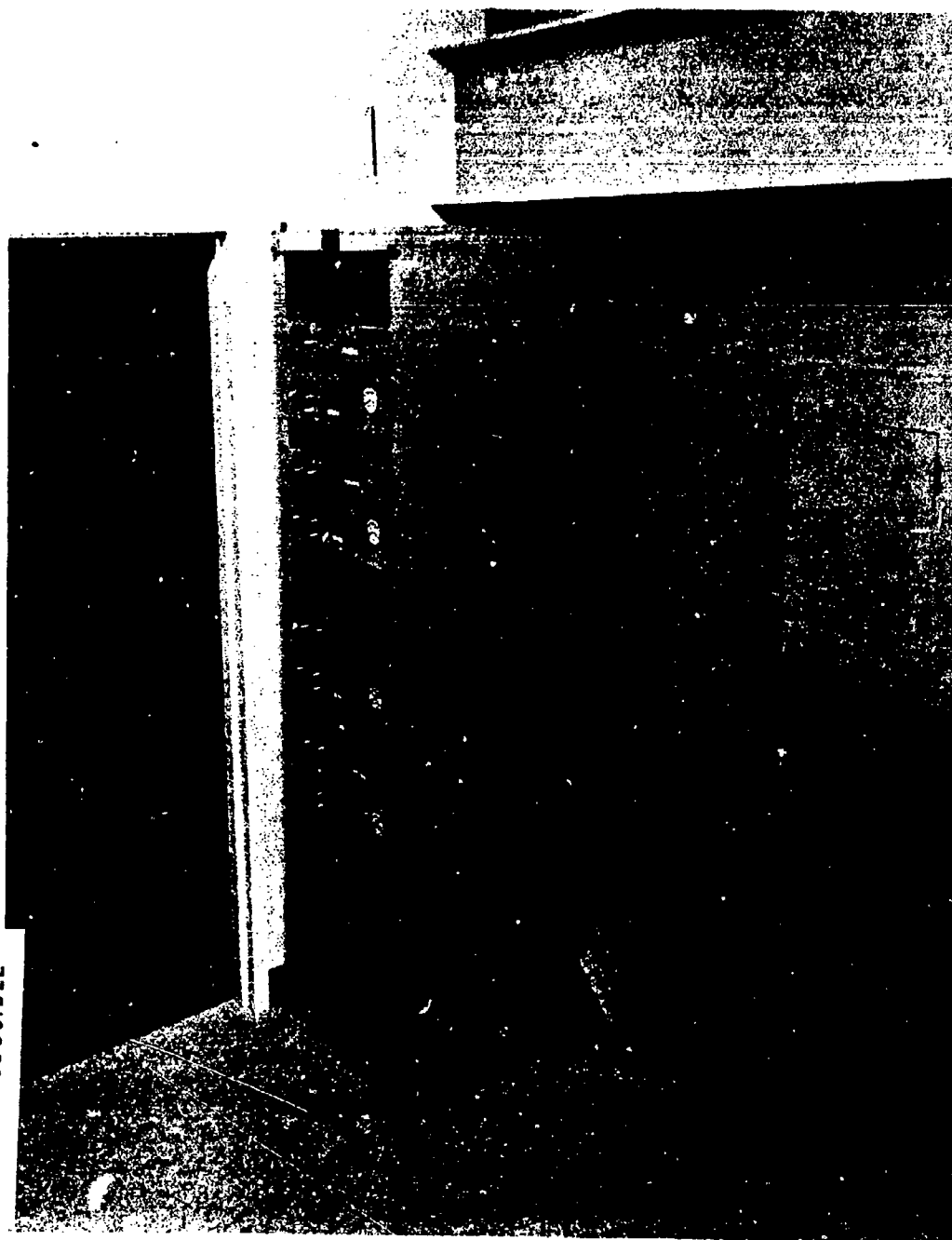


FIGURE 8 - NAFEC JUNCTION ROOM MOCKUP

SUMMARY OF RESULTS

The national program and the tower mockup project, as presented in the scale model and tower laboratories, were very well received. The tower cab size and shape met all functional requirements for a three-position operation. The console, operating equipments and equipment arrangements were judged very good. The decor and general atmosphere created in the tower cab were considered pleasant and desirable.

Main items of concern were the size of the tower cab corner posts and window mullions, and the adequacy and performance of the heating, ventilation and air conditioning system. Several suggestions for improving operational and environmental features were obtained.

CONCLUSIONS

Based on the evaluation tests, it is concluded that:

1. The size and shape of the tower cab meets operational requirements.
2. The tower cab corner posts and window mullions constitute an undue obstruction to vision.
3. The charcoal gray color of the ceiling and other color schemes are acceptable.
4. There are unknown factors relative to the adequate performance of the heating, ventilation, and air conditioning system.
5. There is a diversity of opinion pertaining to the installation, size and use of tower cab window shades.
6. All light systems are excellent.
7. Dimming controls are required for the tower cab stair lights and the dc emergency light.
8. The convenience unit and bookcase area requires a controllable light.
9. The air traffic signal light guns are improperly located for facilities with a high incidence of signal light usage.
10. The overall console design is excellent.
11. The matte-finished formica and gingersnap color of the consoles are pleasing and functionally desirable.
12. Drawers are required, in the console shelves, for storage areas.
13. The carpeted tower cab floor and walls are functionally and aesthetically desirable.
14. The operators' chairs are comfortable, sturdy and an operational requirement.
15. The convenience unit should include a small oven.

16. The preferred location for the recessed jacks for the handsets and/or headsets is in the console equipment turret.

17. The standard GSA bookcase (without modification) is incompatible with the decor of the tower cab.

18. A protective cover is required for the radio equipment rack in the junction room.

19. The hot water heater in the lavatory is improperly located.

20. A diversity of opinion exists pertaining to the location of the ac and dc electrical panel boards.

21. The design of the fluorescent ceiling lights, in the junction room, may create reflections in the tower cab.

22. The stairway configuration from the junction room level to the tower cab is very satisfactory.

23. Personal lockers are required items.

24. The planned use of the elevator shaft area in the 30-foot high towers for a storage area is a housekeeping necessity.

25. Heating and ventilation of the lavatory may be inadequate.

APPENDIX A

GEOGRAPHIC LOCATIONS FOR THE INTERMEDIATE
ACTIVITY LEVEL CONTROL TOWERS

This appendix presents, by States, the designated geographic locations for the 54 Intermediate Activity Level Control Towers.

A list of geographical locations of 54 control towers follows:

Alabama: Tuscaloosa (Van de Graff)

Alaska: Kenai

Arkansas:

Pine Bluff

California:

Carlsbad

Chino

El Monte

Imperial

Lancaster

Livermore

Marysville

San Diego (Brown)

Colorado:

Aspen

Greenwood Village

Connecticut:

Danbury

Groton (Trumbull)

Hartford

Florida:

Fort Lauderdale (Executive)

Gainesville (Municipal)

Vero Beach (Municipal)

Georgia:

Albany (Municipal)

Brunswick (Malcolm McKinnon)

Illinois:

Bloomington

Danville

Indiana:

Bloomington

West Lafayette (Purdue University)

Kansas: Olath (Johnson County)

Kentucky: Paducah

Maryland: Hagerstown

Massachusetts: Norwood (Norwood Memorial)

Michigan:

Ann Harbor

Benton Harbor (Ross Field)

Mississippi: Greenville (Municipal)

Missouri:

Cape Girardeau
Columbia (Mid-Missouri)
Joplin

Nebraska: Grand Island

New York:

Ithaca
Poughkeepsie (Dutchess County)

North Carolina: Hickory (Municipal)

North Dakota: Grand Forks

Ohio: Cleveland (Cuyahoga County)

Oregon: Salem

Puerto Rico: Mayaguez

Tennessee: Knoxville (Downtown)

Texas: Harlingen

Washington: Pasco

West Virginia:

Clarksburg
Morgantown

Wisconsin: La Crosse

Selected tower establishment and tower relocation projects from the FY 1971 and FY 1972 are planned to be included in the procurement based on Air Traffic Service/Airway Facilities Service/Region Coordination.

APPENDIX B

COMPILATION OF CONTROLLER SUGGESTIONS

Contained herein is a compilation of the comments and suggestions of the 39 participating air traffic control specialists.

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QUESTIONNAIRE COMMENTS PART I, TOWER CAB

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 1. <u>CAB VISIBILITY</u> | |
| Remove center mullions | 5 |
| Window mullion too large; remove if possible | 3 |
| Reduce size of corner post | 9 |
| Use tinted glass | 1 |
| 2. <u>CONSOLES</u> | |
| Mount clock higher on consoles | 1 |
| Add flat console for writing, study, maps, etc. | 2 |
| Include study light | 2 |
| Provide VFR strip boards | 4 |
| Provide drawers on front of consoles | 7 |
| Provide desk and typewriter | 1 |
| Does <u>not</u> like standup console | 1 |
| Leave brass latches off consoles | 2 |
| Put lamp dimmers on back of con- sole; use space for Plexiglas for charts and diagrams | 2 |
| Need flat eating area (other than console) | 1 |
| Design standard size Plexiglas shelves for local order | 1 |
| Provide a removable standup writ- ing storage surface for consoles (like a small lectern) with provision for holding strips | 2 |
| Provide space in rear of consoles for binoculars and clipboards | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| <u>2. CONSOLES (continued)</u> | |
| Provision for Electrowriter at local control position | 1 |
| Rubber mats should be covered with glass (rubber comes off on shirts and is hard to remove); SID's, approach plates, etc., should be under glass | 1 |
| Provide mail boxes | 2 |
| Provide pen and pencil holders | 1 |
| Provide storage area under consoles for strips | 1 |
| Round corners of consoles and include cutout for mike jacks | 1 |
| Mount retractable boards under console for reference information | 2 |
| <u>3. CAB RADIO/TELEPHONE EQUIPMENT</u> | |
| Radio/telephone jacks should be in console | 7 |
| Recess plugs in turret | 7 |
| Additional speakers | 3 |
| The two air/ground position can only monitor one frequency; on single man operation, he needs local and ground at same position | 1 |
| Provide override mike at L.C. for training | 2 |
| Telephone access for both air/ground positions so they are interchang- able so trainee can be monitored on either or both | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|---|---|
| <u>3. CAB RADIO/TELEPHONE EQUIPMENT (continued)</u> | |
| Dual communication at all positions | 2 |
| Provide recess for excess mike cord | 1 |
| Add another phone position to right side | 1 |
| Have phone at all three positions | 1 |
| Move speakers to center of positions | 1 |
| Provide headsets | 1 |
| Telephone head pieces on air/ground should be close to field lighting panel to permit unobstructed view of countertop | 1 |
| Move phone up and put jack beneath | 1 |
| Use self-retracting mike cable | 1 |
| Inadequate light indicator on frequency selector | 2 |
| If manual approach control is anticipated, add another mike, radio position and speaker | 1 |
| Frequency selector can be muted too easily | 1 |
| Duplicate all phone jack receptacles in the shelf (for headphone use--eliminates the cord hanging over the shelf) | 1 |
| Put Local Controller M/C junction to left of controller (use mike in left hand, pencil in right) | 1 |
| Longer cords on mikes | 1 |
| Telephone should be installed at ground control position | 2 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 3. <u>CAB RADIO/TELEPHONE EQUIPMENT (continued)</u> | |
| Rearrange both phone panels and land-line speakers to center console each side of FD or CD position. Rearrange speakers to left side of LC position; that is, to the left of FD and rearrange receiver speaker on other LC position so as to be on the right of the controller. The point here is to try and separate between aircraft and land-line calls | 1 |
| Radio land-line interchange <u>not</u> necessary for this type of facility | 1 |
| Relocate radio frequency and volume controls to make more convenient to local controller | 1 |
| Relocate telephones to make more convenient to local controller regardless of which position is used for local controller | 1 |
| Remove portable transceiver and install standby radio | 1 |
| Model CM-190 mike requires a rubber guard be placed against lip--this is unsanitary | 1 |
| Add standby transceiver at local controller | 1 |
| Frequency selector should be 3-way toggle: up--transmit/receive; middle--speaker; down--off | 1 |
| Move speaker to location of frequency select unit | 2 |
| Would like UHF capability | 11 |
| Telephone handset should be recessed into leading or front edge of console | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|---|---|
| 4. <u>FIELD LIGHTING CONTROLS</u> | |
| Locate at local control | 1 |
| Field lighting controls should be laid out in sectors on a schematic map of field designed locally. | 1 |
| Mount to provide room for ILS monitor if needed | 1 |
| 5. <u>CAB LIGHTING</u> | |
| Install overhead light over stove | 10 |
| Relocate dimmer switches | 1 |
| Rheostats should decrease to "off" | 2 |
| Put rheostats on <u>all</u> light switches | 1 |
| Put rheostat on clock | 1 |
| Need only half as many floor lights | 1 |
| Separate variac control for "emer- gency" overhead light | 4 |
| Double area of overhead light (Felts Tower/Spokane) | 1 |
| Move overhead light control to right of stairs, inside tower cab | 1 |
| Accessibility of ceiling lights for bulb replacement | 1 |
| Remove light (emergency?) at top of stairs as it glares to left of tower cab | 1 |
| Put small shade on overhead lights | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|---|---|
| 6. <u>SIGNAL LIGHT GUNS</u> | |
| Move light guns to just in front of controller | 1 |
| Light guns over console | 6 |
| Light gun reels should be combined so they retract simultaneously | 2 |
| At least one light gun should run on batteries | 1 |
| Place light gun on ledge between console and window | 1 |
| 7. <u>WINDOW SHADES</u> | |
| Put window shade strings on corner posts | 2 |
| Relocate shade strings | 1 |
| Single shade per side | 4 |
| Remove window shades altogether | 1 |
| Remove ratchets from window shades | 2 |
| Reduce gap between shades | 1 |
| 8. <u>CONVENIENCE UNIT</u> | |
| Put in lower level | 3 |
| Locate with back to stairwell to get better use of window space | 1 |
| Add oven | 7 |
| Water cooler only in cab | 1 |
| Put in separate exhaust fan if it stays in tower | 1 |
| Additional cupboard space | 2 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 8. <u>CONVENIENCE UNIT (continued)</u> | |
| Provide space for electric coffee pot | 2 |
| Cooking and heating of TV dinner should be limited to junction room and exhaust fan provided | 1 |
| Consider garbage disposal unit in sink | 1 |
| 9. <u>FLOOR SPACE</u> | |
| Tower not large enough for 2 local and 2 ground controllers | 1 |
| 10. <u>WORK SPACE/STORAGE SPACE</u> | |
| Additional storage for forms and supplies | 1 |
| Provide desk area in back of cab | 1 |
| Use built-in bookcase | 5 |
| More horizontal counter space for typewriter, telautograph, etc. | 1 |
| 11. <u>WEATHER INSTRUMENTS</u> | |
| Provide for weather observation equipment | 4 |
| RVR/RVV digital readout is "essential" | 1 |
| Larger numbers on wind direction indicator | 1 |
| Altimeter and wind instruments should have digital readouts | 5 |
| Digitize altimeter | 1 |
| Include ATIS | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comments</u> |
|--|--|
| 12. <u>MISCELLANEOUS</u> | |
| Provide T-Track to remove radar for service | 2 |
| Provide for F-DEP equipment | 1 |
| Reinforce roof for radar antenna and beacon | 1 |
| ILS monitor, desk and spare receiver should have been in mockup | 1 |
| Provide plug and placement for regular clock | 1 |
| Put acoustical tiles on ceiling | 1 |
| Seconds drum on clock should be multicolored | 1 |
| Put gate at stair entrance | 3 |
| Provide a 2-drawer file cabinet | 1 |
| Provide additional storage space | 2 |
| Put carpet on stairwell (1st 3 stairs) for better appearance | 1 |
| Extend carpet on wall to first landing | 1 |
| Enclose overhead portion of stair- well to provide space for binders and watch supervisor position, typewriter, forms, etc. Also a drawer file cabinet | 2 |
| Consider LAWRS incorporated with FLIDAP | 1 |
| AC outlets at rear of cab | 1 |
| Outside door should have pushbutton combination lock | 1 |
| Add escape door to tower wall near book rack | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 13. <u>HEAT, VENTILATION, AIR CONDITIONING</u> | |
| Vents should be inboard of shades | 1 |
| Change vents and shades | 5 |
| Install an exhaust fan | 2 |
| Humidifier and dehumidifier should be standard | 1 |
| Air conditioner should be large enough for desert areas with 5 controllers | 1 |
| Provide 220V outlet for floor heaters | 1 |
| Noise level should be checked by controllers | 2 |
| Make sure unit doesn't fog windows | 1 |
| Make sure ducts are adequate to keep floor warm | 1 |
| Provide electronic air filtration | 1 |

QUESTIONNAIRE COMMENTS PART II, JUNCTION ROOM LEVEL

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 1. <u>STAIRWAY</u> | |
| Make stair smooth with non-skid finish | 2 |
| Put carpeting on stairs | 2 |
| Put on anti-skid pads | 1 |
| Stairs should have safety material on each step. Instead of paint | 1 |
| Use rubber tr | 1 |
| Make skid proof with adhesive | 1 |
| Use more lasting paint on treads | 1 |
| Enclose handrail in stairwell | 7 |
| Have handrail on both sides of towers not equipped with elevators | 2 |
| Use snap-off covers on stairway lighting | 2 |
| Use fluorscent lights in stairwell | 1 |
| Additional light needed around lower portion of stairwell | 2 |
| Darken stairway to prevent reflections in cab | 1 |
| Can large items be carried around corner? | 1 |
| Enclose top to provide extra storage space | 3 |
| First beam in J.R. should be painted yellow to warn very tall people | 1 |
| Close off stairwell for air conditioning | 2 |
| Install movable louvers in door to catwalk | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|---|---|
| 2. <u>RADIO EQUIPMENT RACK</u> | |
| Protect from public misuse | 4 |
| Locate below tower | 1 |
| Place in corner to conserve space | 1 |
| Locate on main floor | 2 |
| Locate in storage room | 1 |
| Put casters on it | 3 |
| Put monitor speaker in equip rack for controller in lavatory on 1-man operation | 1 |
| 3. <u>LAVATORY</u> | |
| Reverse position of sink and toilet | 1 |
| Put a urinal in lavatory | 5 |
| Install a shower | 4 |
| Put in false ceiling | 9 |
| Put in medicine cabinet and first aid kit | 2 |
| Panel walls | 2 |
| Relocate hot water heater | 1 |
| Put in window, or separate switch for fan | 2 |
| Separate switch for fan | 1 |
| Vent in lower half of door | 2 |
| Provide hangers and paper towels | 1 |
| Provide way to monitor speakers in rest room | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 3. <u>LAVATORY (continued)</u> | |
| Run HVAC duct to rest room | 2 |
| Put in an electrical outlet | 1 |
| Put in janitorial closet | 1 |
| 4. <u>LOCKERS</u> | |
| Put in personal lockers | 15 |
| Put lockers in lavatory | 1 |
| 5. <u>CIRCUIT BREAKERS</u> | |
| Put in circuit breakers in lavatory | 2 |
| Eliminate space between C.B. boxes to conserve space | 1 |
| Move circuit breakers to right hand corner | 6 |
| Put circuit breakers in tower cab | 2 |
| 6. <u>MISCELLANEOUS</u> | |
| First step in ladder is too close to beam | 3 |
| Put cage on ladder | 8 |
| Put escape rig on ladder in 60 and 90-foot towers | 1 |
| Lock on emergency ladder access to catwalk | 1 |
| Provide key lock on door | 2 |
| Closed circuit TV at entrance (security) | 1 |
| Exterior hinges on catwalk door can be removed too easily | 1 |
| Make last section of ladder retractable for security | 2 |
| Use electric coded lock on outside door | 2 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 6. <u>MISCELLANEOUS (continued)</u> | |
| Bolt-type lock inside escape hatch door | 2 |
| Install intercom to front door | 1 |
| Electric door lock at base | 1 |
| Extra 220V outlet to tower stove for 220V heater | 1 |
| Provide HVAC outlets to junction room | 2 |
| May need additional heat in extremely cold climate | 2 |
| Door at top of steps, leading to cab | 1 |
| Put shelves in storage room | 1 |
| Put coat rack to right of lavatory entrance | 1 |
| Put desk in J.R. | 1 |
| Put in tape recorder | 3 |
| Provide slop sink for janitor | 2 |
| Install storage shelves and broom closet | 1 |
| Recess lighting fixture | 1 |
| Put additional light at stairway base | 1 |
| J.R. paint should be lighter and brighter | 2 |
| One emergency light in cab, pointing downward | 3 |
| Window in Chief's office | 2 |
| Window in elevator shaft room | 1 |
| Additional spigot on opposite side of tower | 1 |

| <u>Comment</u> | <u>Number of persons making same or similar comment</u> |
|--|---|
| 6. <u>MISCELLANEOUS (continued)</u> | |
| Put wiring in troughs | 1 |
| Exposed beams and conduits should be covered | 4 |
| Install tape recorder in J.R. - not first floor | 1 |
| Can desk and bookcase be carried up stairwell? | 1 |
| Put gutter and downspout to protect walls of tower | 1 |
| Provide small ledge around floor of catwalk | 1 |
| Floor of catwalk should be solid | 1 |
| More durable floor covering for J.R. | 2 |
| Stop elevator at most advantageous floor | 1 |

APPENDIX C

QUESTIONNAIRES GIVEN TO CONTROLLER SUBJECTS

This appendix contains the questionnaires given to the controllers and a compilation of the responses.

QUESTIONNAIRE

EVALUATION OF INTERMEDIATE ACTIVITY LEVEL ATC TOWER CAB Project 144-170-06X

PART I - The Tower Cab

1. Extent of unobstructed visibility through tower cab windows
4 Unacceptable 8 Fair 10 Good 11 Excellent
2. Skyward visibility (as limited by height of windows and location of roof)
0 Unacceptable 1 Fair 10 Good 23 Excellent
3. Groundward visibility (as limited by window ledge, consoles, and catwalk)
0 Unacceptable 1 Fair 10 Good 27 Excellent
4. Overall design of consoles
0 Unacceptable 4 Fair 18 Good 17 Excellent
5. Height of the writing surface on the console
0 Unacceptable 1 Fair 9 Good 28 Excellent
6. Texture and finish of writing surface
1 Unacceptable 1 Fair 14 Good 23 Excellent
7. Color and finish of consoles
0 Unacceptable 0 Fair 14 Good 25 Excellent
8. Design of radio frequency and volume controls
3 Unacceptable 5 Fair 20 Good 11 Excellent
9. Location of radio frequency and volume controls
1 Unacceptable 7 Fair 25 Good 6 Excellent
10. Location of the telephone equipment
2 Unacceptable 4 Fair 24 Good 7 Excellent
11. Design of the field light control panel
1 Unacceptable 5 Fair 15 Good 18 Excellent
12. Location of the field light control panel
0 Unacceptable 2 Fair 22 Good 10 Excellent
13. Adequacy of the floor lights
0 Unacceptable 0 Fair 6 Good 33 Excellent

3-3

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| Original NA-550 | Date 9/7/71 | Quantity 100 | APPROVED FORM |
|--------------------|----------------|-----------------|------------------|

2

**Questionnaire - Evaluation of Intermediate Activity Level ATC Tower Cab
(Continued)**
Project 144-170-06X

14. Location of the floor lights
0 Unacceptable 1 Fair 11 Good 27 Excellent
15. Adequacy of position (console) lights
0 Unacceptable 1 Fair 11 Good 27 Excellent
16. Location of the position light switches
1 Unacceptable 2 Fair 15 Good 20 Excellent
17. Location and mounting of signal light guns
6 Unacceptable 3 Fair 22 Good 8 Excellent
18. Location and operation of window shades
3 Unacceptable 11 Fair 17 Good 6 Excellent
19. Presence of convenience unit in tower cab
2 Unacceptable 1 Fair 9 Good 27 Excellent
20. Color and finish of convenience unit
0 Unacceptable 3 Fair 19 Good 17 Excellent
21. Location of convenience unit
2 Unacceptable 2 Fair 18 Good 17 Excellent
22. Adequacy of floor space for two controllers
0 Unacceptable 0 Fair 5 Good 34 Excellent
23. Adequacy of floor space for three controllers
0 Unacceptable 1 Fair 12 Good 26 Excellent
24. Adequacy of floor space for four controllers
2 Unacceptable 12 Fair 19 Good 6 Excellent
25. Based on what you can tell from the mockup and the model, what is your overall evaluation of the tower cab?
0 Unacceptable 3 Fair 14 Good 22 Excellent

QUESTIONNAIRE

EVALUATION OF INTERMEDIATE ACTIVITY LEVEL ATC TOWER CAB Project 144-170-06X

PART II - Junction Room Level

1. Ease of access to the catwalk
0 Unacceptable 2 Fair 19 Good 17 Excellent
2. Design and construction of the stairway from junction room to tower cab
0 Unacceptable 5 Fair 22 Good 11 Excellent
3. Lighting in stairwell
3 Unacceptable 2 Fair 17 Good 16 Excellent
4. Design and construction of lavatory
2 Unacceptable 8 Fair 23 Good 4 Excellent
5. Location of radio equipment
2 Unacceptable 10 Fair 18 Good 8 Excellent
6. Junction room color
0 Unacceptable 2 Fair 22 Good 14 Excellent
7. Junction room lighting
0 Unacceptable 3 Fair 16 Good 19 Excellent
8. Based on what you can tell from the mockup and the model, what is your overall evaluation of the junction room
1 Unacceptable 2 Fair 26 Good 8 Excellent

| | | | |
|------------|--------|----------|----------|
| Originator | Date | Quantity | APPROVED |
| NA-550 | 9/7/71 | 100 | FORM |

2

Questionnaire - Evaluation of Intermediate Activity Level ATC Tower
(Continued) Project 144-170-06X

9. Is there anything in the junction room you feel it is **ESSENTIAL** to **ADD, REMOVE, or CHANGE**?

NOTE: SEE APPENDIX B FOR COMMENTS

10. Is there anything in the junction room you feel it would be **DESIRABLE** to **ADD, REMOVE, or CHANGE**?

NOTE: SEE APPENDIX B FOR COMMENTS